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Physical Growth of Children Under Five Years of Age in Nchelenge, Zambia: Results From a District Survey

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ABSTRACT This study focuses on the physical growth of children aged 0–60 months in Nchelenge District, northeast Zambia. By means of a two-stage clustered and random sampling method, 193 households were selected. Weight, height, and mid-upper-arm circumference (MUAC) of children 0–60 months were measured. Underweight, stunting, and wasting were defined as weight for age, height for age, and weight for height (W/H), respectively, $\leq$2 z scores below the median of the National Center for Health Statistics (NCHS) reference population. Among 250 children, prevalence rates of 30% underweight, 69.2% stunting, and 4.4% wasting were found, with the highest rates at age 12–<24 months. Prevalence of stunting, underweight, and wasting in children aged 0–<6 months and 6–<12 months suggested that a substantial proportion of infants were premature and/or small for gestational age. The literature suggests that prematurity and intrauterine growth retardation may be quite common in Africa, and this may have important implications for the interpretation of growth data and under nutrition rates. Use of the MUAC < 125 mm as an indicator of wasting resulted in higher estimates of wasting compared to W/H ≤ -2 z scores, and seemed unsuitable as a screening test for wasting in this Zambian population.

Protein-energy malnutrition among preschool children remains a major cause of morbidity and mortality in developing countries (Haaga et al., 1985; Briend et al., 1986; Carlier et al., 1991; Van Den Broeck et al., 1993). While vaccination campaigns and Under Five Clinics (UFCs) on a regular basis have reduced considerably some infectious diseases, malnutrition is remarkably persistent in its occurrence (Keller and Fillmore, 1983; Anonymous, 1984; Maletnlema, 1992; Nahata, 1992; Tumwine and MacKenzie, 1992; Helen Keller International, 1993). An association with low educational levels, poor standards of hygiene and sanitation, few financial means, and demographic factors such as low maternal age or small birth intervals are often reported (Haaga et al., 1985; Ocloo, 1993) to imply that malnutrition is, as it were, part of the human condition of the poor.

In Nchelenge District in northeast Zambia, growth retardation and malnutrition are common despite a history of more than 20 years of conducting UFCs and considerable economic development. We report the findings of a survey in Nchelenge District on the physical growth of children up to 5

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years of age. We also identify factors that could account for the apparent persistence of growth retardation, and examine the usefulness of the mid-upper-arm circumference as a screening test for wasting.

SUBJECTS AND METHODS

The survey area

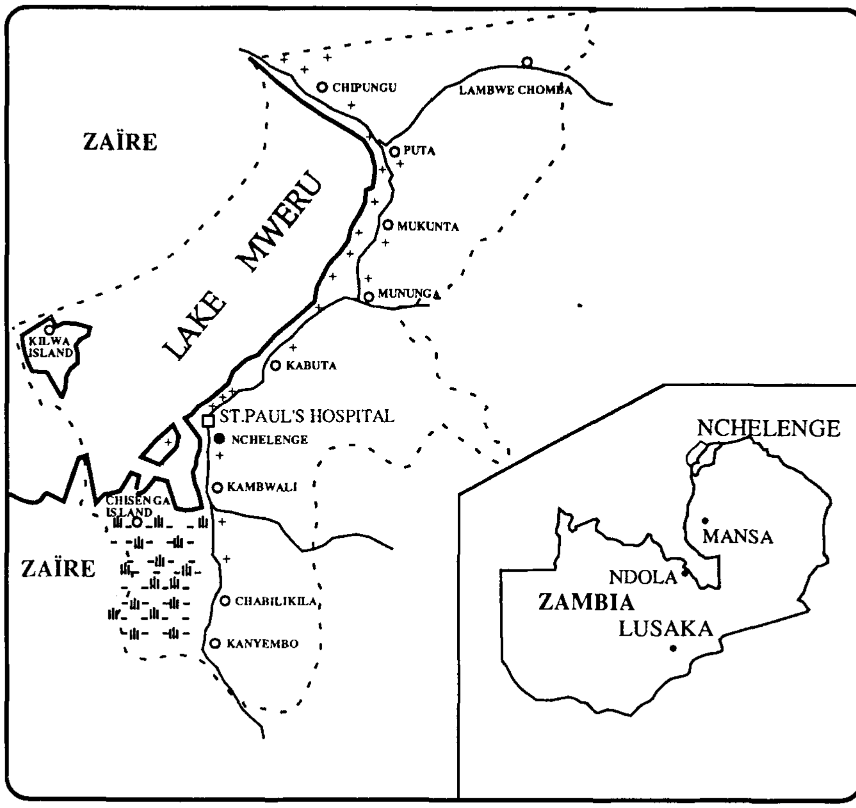
Nchelenge District is situated in Luapula province in northeast Zambia along the shore of Lake Mweru, which borders Zaïre (Fig. 1). The District measures about 220 by 70 km and lies approximately 950 m above sea level. Three types of landscape can be distinguished: the plateau (east and northeast), the valley (along the lake), and the swamps (mainly northwest and southwest). There are three more or less distinctive seasons: cool and dry (May–July), hot and dry (August–November), and rainy (December–April). In 1987 the Ministry of Health estimated the District population in 1988 at 105,681, with an annual increase of 3.5%, the infant mortality rate at 101 per 1,000, and the percentage of the population under 5 years of age at 19% (in 1988, 20,079 children) (Ministry of Health, 1987).

The majority of the people live in the valley, along the lakeshore, where fishing and fish dealing are often combined with farming. Fishing is the main source of income; large quantities are traded to other areas. The main crops grown are cassava, maize, ground-nuts, beans, and green vegetables. The people belong to the Ba-Bemba, and the only language is ci-Bemba. Most people adhere to the Christian religion, though traditional religion—among others, belief in witchcraft—exerts a powerful influence. Health facilities consist of a District hospital, St. Paul's Hospital with 160 beds, operative since 1962, and 12 Rural Health Centres (RHCs) spread out over the District. The major causes of mortality in children are malaria/anemia, pneumonia, protein-energy malnutrition, diarrhea, and meningitis. By all RHCs and by a Hospital Mobile Team, monthly UFCs are conducted, during which the children are weighed, monitored, and vaccinated, and health education is given (Annual Report, 1987).

Survey design and sampling

The sampling unit consisted of all household dwellings in the sections mentioned in the "Working Paper Party Structure 1987 Nchelenge District." The sampling frame was this document and the sampling selection was done by two-stage clustered and random sampling (Lutz, 1981).

The design of the survey was based on the district organization as developed by the main political party in Zambia, the United National Independence Party (UNIP). At Nchelenge District level, UNIP was organized in 20 wards, which were subdivided into 2–4 branches, and each branch into 10 sections. A section corresponded to a small village or a part of a bigger village. Each section had its own political representative, who knew exactly for which area he/she was responsible. From the "Working Paper Party Structure 1987 Nchelenge District" a list of all sections in the district (635 in number) was compiled. Using random numbers, 30 were selected. The sections selected were situated in 14 different wards and included both rural and semirural areas. All sections were visited, the purpose of the study explained, and permission obtained from all village headmen/headwomen and section representatives. Five sections no longer existed, as the people had migrated elsewhere because of better fishing opportunities. These five sections were not confined to one area and no replacement for them was taken. Of the 25 remaining sections, the houses were counted. These totaled 1,814 houses (mean $\pm$ SD = 72.1 $\pm$ 59.9; range 14–293). The mean number of houses per section, 60, was taken as the sampling interval. For every 60 houses a sample, consisting of a cluster of seven households to be examined, was taken. In order to randomly select a cluster of households within a section, a direction was chosen by rotating an empty bottle on a horizontal board at the geographic center of the section. The houses in a straight line up to the outer section border were counted and, randomly, one was selected. If this household contained one or more children below 60 months of age, it was eligible for inclusion, If not, the next household, defined as living in the house which had the front



Notes:
- o Rural Health Centre
- \+ MCH subcentre
- -ılı- Swamps
- ● District Capital Rural Health Centre

Fig. 1. The Republic of Zambia, Nchelenge District (scale 1:750,000).

door physically closest to the front door of the first house, was approached. If more than one cluster had to be taken from the same section, the entire procedure was repeated after the first seven interviews.

Sampling results

Two hundred and fifteen households were eligible for the study. In seven cases the mother refused. The reasons given were: too busy or cooking (four), illness (two), and language problems (only ki-Swahili spoken; one). In 15 cases, no one was at home, but the information was obtained from neighbors that children up to 60 months of age were part of the household. Reasons for absence of the family allegedly included: funeral (two), fishing camp (one), gone to Zaïre (three), and not known (nine). These 22 households were spread out over 13 different sections and were not confined to one area. Thus, in 193 out of 215 households (90.1%) the children were examined.

Data collecting, processing, and analysis

Data collection took place from November 29, 1988 to February 7, 1989. Prior to the survey, training sessions were held to minimize interobserver variation in measurements (World Health Organization, 1983). Age was assessed from birth certificates, Under Five Cards, or local calendars. In the

local calendar a year was subdivided into months as is customary in Western countries. In addition, the local calendar featured local names for the months, annual festivities, and key events from the past 5 years. Sex was determined by the mother's description or from birth certificates and Under Five Cards. Growth was assessed with anthropometry. Weight, height, and mid-upper-arm circumference (MUAC) were measured according to standard anthropological methods (Jelliffe, 1966; World Health Organization, 1983; Morley and Woodland, 1984; Peterson et al., 1985). For infants and children under 2 years of age, recumbent length (crown–heel length) was measured by means of a wooden length-board. For older children a vertical measuring rod was employed (World Health Organization, 1983).

From the anthropometric data, z scores were calculated for weight for age (W/A), height for age (H/A), and weight for height (W/H) based on the reference values from the United States National Center for Health Statistics (NCHS), as recommended by the WHO (National Center for Health Statistics, 1977; World Health Organization, 1983), A z score (or standard deviation score) is the difference between the actual measurement and the median of the age- and sex-matched reference population divided by the standard deviation of the reference (Anonymous, 1993; World Health Organization, 1983). Values of 2 z scores or more below the median were considered subnormal. W/A ≤ -2 z scores are referred to as underweight, H/A ≤ -2 z scores as stunting, and W/H ≤ -2 z scores as wasting. The MUAC is considered to be relatively age independent for children 12–60 months. Values of the MUAC were classified into three generally accepted categories: <125 mm, 125–135 mm, and >135 mm. An MUAC <125 mm is thought to indicate the presence of wasting, whereas values >135 mm denote an adequate nutritional state (Blankhart, 1969; Shakir and Morley, 1974; Morley and Woodland, 1979).

Data processing followed standard procedures. Chi-square testing for statistical significance was done, when appropriate, with Yates' continuity correction. In order to evaluate the effects of sex and age on various growth measures, two-way analysis of variance was performed. Differences between group means were evaluated using Tukey-B's multiple comparison procedure. Because in some households multiple children were examined who are not independent from one another, the maximum number of the degrees of freedom in statistical testing was limited to the number of households instead of to the number of subjects examined. P values <0.05 were considered significant.

TABLE 1. Age and sex distribution of 275 children under 5 years of age from a random sample of households at Nchelenge, Zambia

Age (months)	Male	Female	Not known	Total
0–<6	12	15	2	29 (10.5%)
6–<12	19	16	4	39 (14.2%)
12–<24	33	33	9	75 (27.3%)
24–<36	29	14	3	46 (16.7%)
36–<48	20	19	3	42 (15.3%)
48–60	19	21	4	44 (16.0%)
Total	132	118	25	275 (100%)

RESULTS

The 193 households examined contained 275 children, for whom exact birthdates were available in 73.5% of the cases. The age and sex distribution are presented in Table 1. Sex was not recorded in 25 children due to technical errors. The age distribution did not differ between males, females, and children with unknown sex ($\chi^2 = 6.86$, 10 df, $P = 0.739$).

Mean weight, height, and MUAC according to age and sex are shown in Table 2. The mean weights in various age groups did not differ according to sex (F = 0.205, 1 df, $P = 0.651$). To obtain a cross-sectional growth curve of the community sample, averaged weights per age group were plotted for age (Fig. 2). The reference curves shown (NCHS median values for boys and -2 z scores for girls) are as recommended for the prototype WHO growth chart (World Health Organization, 1986).

For mean height there was no significant overall effect of sex in the various age groups (F = 0.103, 1 df, $P = 0.748$). Within the 0–<6 months group, however, mean height was lower for females than for males (F = 4.214, 26 df, $P = 0.0027$).

For the 250 children with known sex, z

TABLE 2. Weight, height, and arm circumference (MUAC) (mean ± SD) according to sex and age group (months) of 275 children[1] from a random sample of households at Nchelenge, Zambia

Age	Weight (kg)			Height (cm)			MUAC (mm)		
	Male	Female	Not known	Male	Female	Not known	Male	Female	Not known
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
0–<6	5.74 ± 1.59	5.41 ± 1.26	4.25 ± 0.35	58.0 ± 3.6	53.1 ± 4.7*	54.0 ± 4.2	131 ± 17	125 ± 13	108 ± 4
6–<12	7.81 ± 1.12	7.16 ± 0.79	7.48 ± 1.39	63.7 ± 4.6	64.9 ± 4.7	61.3 ± 2.8	136 ± 11	130 ± 10	135 ± 13
12–<24	8.78 ± 1.45	8.61 ± 1.46	9.0 ± 1.61	71.1 ± 5.1	70.3 ± 6.5	74.3 ± 8.0	134 ± 12	134 ± 18	138 ± 10
24–<36	11.23 ± 2.18	10.84 ± 1.85	12.17 ± 2.31	79.9 ± 7.1	79.8 ± 7.2	86.0 ± 15.0	145 ± 12	145 ± 13	145 ± 9
36–<48	12.19 ± 2.42	12.47 ± 2.03	11.10 ± 0.85	81.6 ± 9.1	84.9 ± 6.0	82.7 ± 4.7	152 ± 12	151 ± 12	140
48–60	14.17 ± 2.08	14.70 ± 1.92	14.75 ± 1.85	91.6 ± 6.3	93.4 ± 7.1	94.5 ± 6.8	158 ± 14	164 ± 11	158 ± 16

[1] Under 5 years of age.
* Male vs. female: $P = 0.0027$.

scores for W/A, H/A, and W/H were calculated (Table 3); the distribution curves as compared to the reference population are shown in Figure 3. Prevalences of underweight, stunting, and wasting according to age are indicated in Table 4. Overall, underweight was present in 75 children (30%), stunting in 173 (69.2%), and wasting in 11 (4.4%).

The mean z scores of W/A in various age categories did not differ according to sex (F = 2.789, 1 df, $P = 0.096$). There was a clear effect of age (F = 5.696, 5 df, $P < 0.0005$). Z scores at 12–<24 months were lower than at 0–<12 months and at 48–60 months. The 0–<6-month-old children had higher z scores than children between 6 and 48 months ($P < 0.05$). The prevalence of underweight was highest in the groups aged 12–<24 (48.5%) and 24–<36 months (39.5%).

For the H/A z scores, analysis of variance showed a possibly significant effect of sex (F = 3.947, 1 df, $P = 0.048$) as well as an effect for age (F = 2.646, 5 df, $P = 0.024$). At 0–<6 months, H/A z scores for females (-2.91 ± 1.84) were lower than for males (-1.43 ± 1.32) ($t = 2.27$, 23 df, $P = 0.033$). At 6–<12 months, however, z scores for females (-1.73 ± 1.21) were higher than for males (-3.03 ± 1.37) ($t = -2.92$, 32 df, $P = 0.0006$). Above 12 months of age, no sex differences in H/A z scores were observed ($P \geq 0.09$). Stunting prevalences were high in all age groups (51.9–80.3%), especially in the 12–<24-month-old children (80.3%).

For the mean z scores of W/H, no effect of sex was observed (F = 0.017, 1 df, $P = 0.897$). There was a clear effect of age, however (F = 4.6842, 5 df, $P < 0.0005$). For children 12–<24 months and 24–<36 months, W/H z scores were lower (0.27 ± 1.54 and 0.36 ± 1.20, respectively) than for the 0–<6 month group (1.85 ± 2.21) ($P < 0.05$). Wasting occurred most frequently among the children aged 0–<6 months (7.4%) and 12–<24 months (7.6%).

For the mean MUAC (Table 2), no effect of sex was observed (F = 0.528, 1 df, $P = 0.468$). The relationship between age and mean MUAC, however, was highly significant (F = 39.296, 5 df, $P < 0.00005$). Children below 24 months of age had lower

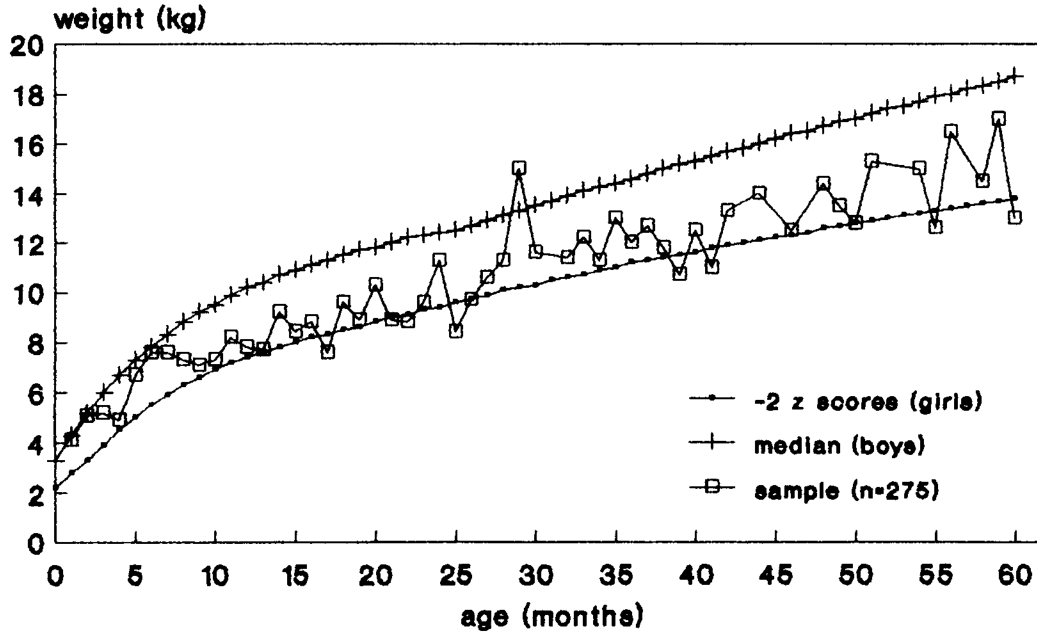


Fig. 2. Mean weight according to age for 275 children aged 0–60 months from Nchelenge, Zambia. Reference lines are as recommended by the World Health Organization (1986).

TABLE 3. Z scores (mean ± SD) of weight for age, height for age, and weight for height according to age (months) and sex of 250 children[1] from a random sample of households at Nchelenge, Zambia

	Weight for age		Height for age		Weight for height	
	Male	Female	Male	Female	Male	Female
Age	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
0–<6	−0.31 ± 1.22	−0.35 ± 1.57	−1.43 ± 1.32	−2.91 ± 1.84*	1.40 ± 1.81	2.23 ± 2.51
6–<12	−1.17 ± 1.26	−1.15 ± 0.88	−3.03 ± 1.37	−1.73 ± 1.21**	1.54 ± 1.69	0.43 ± 1.60
12–<24	−2.24 ± 1.15	−1.75 ± 1.30	−3.48 ± 1.46	−3.08 ± 2.33	0.88 ± 1.54	0.45 ± 1.55
24–<36	−1.43 ± 1.54	−1.44 ± 1.21	−2.73 ± 1.96	−2.55 ± 1.99	0.37 ± 1.14	0.36 ± 1.36
36–<48	−1.71 ± 1.45	−1.19 ± 1.38	−3.76 ± 2.32	−2.65 ± 1.55	1.14 ± 1.15	0.87 ± 1.51
48–60	−1.14 ± 1.10	−0.94 ± 1.07	−2.84 ± 1.53	−2.36 ± 1.59	0.66 ± 1.74	0.92 ± 1.14

[1] Under 5 years of age. NCHS reference values.
* Males vs. females: $P = 0.033$.
** Males vs. females: $P = 0.006$.

MUACs than those above. The mean MUAC for 0–<6 months was lower than for 12–<24 months. Finally, children aged 48–60 months had higher mean MUACs than those below 48 months of age ($P < 0.05$).

The MUACs for various age groups with generally accepted cutoff values are indicated in Figure 4. For children ≥12 months, prevalence of a MUAC <125 mm, often considered indicative of wasting, was 8.3%.

Table 5 shows various characteristics of the MUAC as a screening test for wasting. If W/H ≤ −2 z scores is accepted as a definite criterion to identify wasting, the sensitivity of the MUAC, i.e., the percent with MUAC below the cutoff of children with W/H ≤ −2 z scores, ranged from 20% to 57%, depending on the age group and cutoff value chosen. False negative rates (percent with MUAC ≥ cutoff of children with W/H ≤ −2 z scores) were between 43% and 80% for various age groups and cutoff values. Test char-

TABLE 4. Prevalence rates (%) of underweight, stunting, and wasting according to age (months) in 250 children[1] from a random sample of households at Nchelenge, Zambia

Age	Underweight	Stunting	Wasting
0–<6	14.8	51.9	7.4
6–<12	14.3	60	—
12–<24	48.5	80.3	7.6
24–<36	39.5	62.8	4.7
36–<48	23.1	79.5	2.6
48–60	20	67.5	2.5
Total	30	69.2	4.4

[1] Under 5 years of age; underweight, stunting, and wasting defined, respectively, as weight for age, height for age, and weight for height ≤ −2 z scores (NCHS reference values).

acteristics were somewhat better in the 12–<24 month group than in older children.

DISCUSSION

This study is the first to provide reliable anthropometric data in a random sample of households with children aged 0–60 months in Nchelenge District, Zambia.

Prevalence rates of growth variables obviously depend on the definitions employed. We chose to use z scores as indicators, because these allow easy comparison with other data and the reference population irrespective of age (Fig. 3). This does not hold for another widely used indicator of growth, namely the percentage of the median (% median). As the relationship between z scores and the percentage of the median varies with the age of the child, meaningful comparison of prevalence rates based on percentages of the median between different age groups and with the reference population is limited (Keller and Fillmore, 1983; WHO Working Group, 1986). In the literature cited below, z scores have been used to define underweight, stunting, and wasting, unless indicated otherwise.

In our study, there was no relationship between sex and weight, MUAC, W/A, and W/H z scores. Girls, however, had lower heights and H/A z scores than boys of 0–<6 months, but at ages 6–<12 months females had higher z scores than males. Height at birth is generally lower for girls as compared to boys (Tjon A Ten et al., 1986; World Health Organization, 1983). The reversed sex difference for H/A z scores at 6–<12 months is difficult to explain. Possibly, it is a chance finding.

The overall percentage of underweight children (30%) and the higher occurrence in the 12–<24 month group (48.5%) in Nchelenge is comparable to that found elsewhere in Africa (Anonymous, 1984; Haaga et al., 1985). In 1978 an Ethiopian study mentioned 28.6% of children 0–5 years to be underweight (Keller and Fillmore, 1983), whereas in Tanzania a 38.7% prevalence (% median) was reported (Kimati and Scrimshaw, 1985). In 1985 the World Health Organization estimated that about 35% of preschool-aged children in Africa were underweight (Haaga et al., 1985). Among the 12–<24 month group underweight prevalence was reported to be about 40% in Africa (Anonymous, 1984). However, rates of about 50% in this age group, as observed in our study, were found in Botswana, Burundi, Ivory Coast, and Madagascar (Keller and Fillmore, 1983). Much lower rates of underweight (10.3%) were recently reported from Kenya (Vonk et al., 1993).

The overall rate of wasting found in this study (4.4%) is comparable to that found in Zaïre (% median) in 1984 (Franklin et al., 1984), in Senegal in 1991 (Carlier et al., 1991), and in Malawi during the peak hunger months in 1989 (Kurth, 1989), but much lower than in Ethiopia, where 12.5% wasting was reported in 1993 (Yusuf et al., 1993). The observation that the 12–<24 month group showed the highest wasting rate compared to other age groups is an almost universal finding of surveys from Africa and elsewhere (Keller and Fillmore, 1983). The 7.6% wasting prevalence at age 12–<24 months in Nchelenge compares favorably with reports from Botswana (12.5%), Ghana, and Burundi (39.0%), but is in line with observations from Zaïre (9.6%) and rural Kenya (7.4%) (Keller and Fillmore, 1983).

The prevalence of stunting observed here (69.2%) is considerably higher than reported elsewhere from sub-Saharan Africa, and this holds for all age groups (Keller and Fillmore, 1983; Kurth, 1989; Carlier et al., 1991). In urban Zaïre stunting occurred in 23.8–41.6% (% median) at age 6–59 months (Franklin et al., 1984), whereas in Malawi a rate of 40.5% was reported (Kurth, 1989). In Tanzania, however, up to 64.5% (% median) of preschool children were stunted (Kimati et al.,

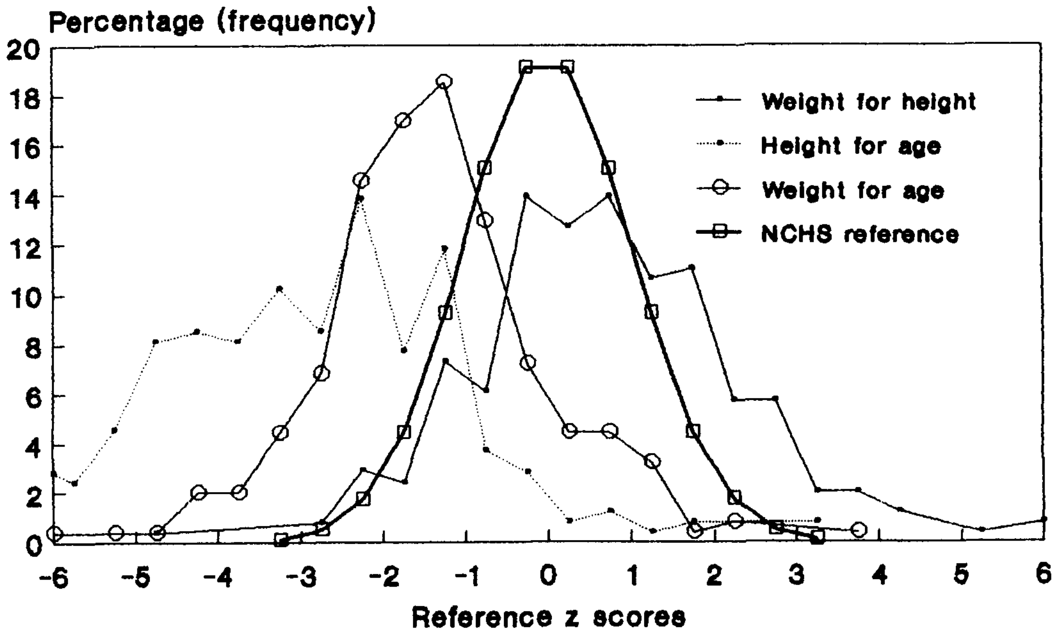


Fig. 3. Distribution curves for weight/height, height/age, and weight/age in relation to reference z scores. Data from 250 children aged 0–60 months from Nchelenge, Zambia.

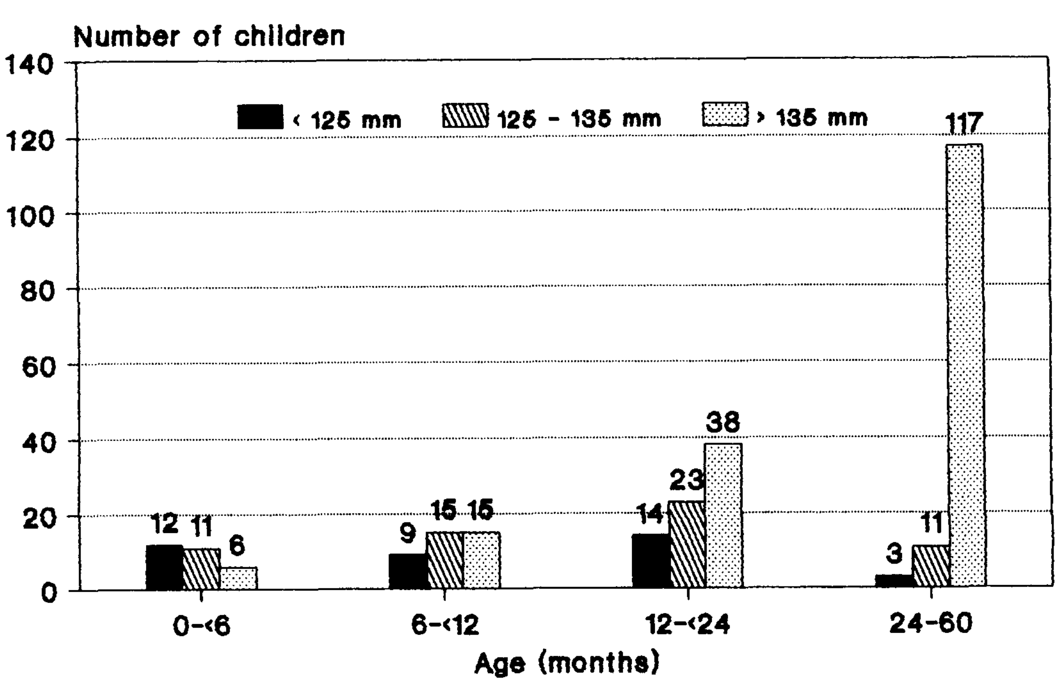


Fig. 4. Mid-upper-arm circumference (mm) in 275 children aged 0–60 months from Nchelenge, Zambia.

TABLE 5. Sensitivity, specificity, false positive rate (FPR), false negative rate (FNR), and positive (PPV) and negative predictive value (NPV) for various cutoff values (in mm) of the mid-upper-arm circumference (MUAC) with W/H ≤−2 z scores as the anthropometrical standard for wasting, according to age group (months) in 207 children aged 12–60 months from a random sample of households at Nchelenge, Zambia

	Cutoff value (MUAC)								
	125 mm			130 mm			135 mm		
Age	12–<24	24–60	12–60	12–<24	24–60	12–60	12–<24	24–60	12–60
Sensitivity[1]	42.8	20	25.0	57.1	33.3	41.7	57.1	40	50.0
Specificity[2]	79.1	97.5	92.6	58.2	93.4	91.0	52.2	90.2	80.4
FPR[3]	20.9	2.5	7.4	41.8	6.6	9.0	47.8	9.8	58.3
FNR[4]	57.1	80	75.0	42.9	66.7	58.3	42.9	60	50.0
PPV[5]	17.6	25	17.6	12.5	20	22.7	11.1	14.3	14.0
NPV[6]	93.0	96.7	95.1	93.0	96.7	96.1	92.1	97.3	96.2

[1]Sensitivity = true positive rate (% with MUAC < cutoff of cases with W/H ≤−2 z scores). [2]Specificity = true negative rate (% with MUAC ≥ cutoff of cases with W/H >−2 z scores). [3]False positive rate = % with MUAC < cutoff of cases with W/H >−2 z scores. [4]False negative rate = % with MUAC ≥ cutoff of cases with W/H ≤−2 z scores. [5]Positive predictive value = % with W/H ≤−2 z scores of cases with MUAC < cutoff. [6]Negative predictive value = % with W/H >−2 z scores of cases with MUAC ≥ cutoff. NCHS reference values.

1985). Usually, but not invariably, higher stunting rates have been found in the 12–<24 month group (Keller and Fillmore, 1983; Carlier et al., 1991). In Botswana, stunting occurred in 55.9% at age 12–<24 months, as opposed to about 40% in other age groups, but in Kenya, Sierra Leone, Zaïre, and Malawi, as in our study, stunting rates at age 12–<24 months were not different from those of older children (Keller and Fillmore, 1983; Kurth, 1989).

Several explanations could be put forward to explain the high prevalence of stunting found in this study. Firstly, age bias may play a role. Because UFC Cards or birth certificates as an objective source of information on age were not available in 26.5% of the children, overestimation of age in these children may have resulted in too-high figures on stunting prevalence. However, underweight prevalence rates are also dependent on age estimation. Therefore, our finding of underweight prevalences similar to those mentioned in other studies argues that age bias is unimportant.

Secondly, differences in measurement techniques between our study and others might be involved. Although the measurement training sessions were held according to the WHO guidelines (World Health Organization, 1983) and close supervision continued throughout the survey, this possibility cannot be dismissed altogether.

Thirdly, the observation that in the 0–<6 month group stunting prevalence was high (51.9%) suggests the distinct possibility of a substantial number of premature infants in this age group.

Prevalence rates of prematurity (gestational age ≤ 37 completed weeks) are difficult to obtain in Africa, because gestational age usually remains unknown. Most studies therefore use the term "low birth weight" (LBW), defined as a birthweight below 2,500 g (Ifekwunigwe, 1985). LBW may be due to prematurity, intrauterine growth retardation, or a combination of both (Adelusi and Ladipo, 1976; Singh and Gupta, 1977; Boersma and Mbise, 1979; Mbise and Boersma, 1979; Bantje, 1982; van Eijk, 1986). While in Western countries LBW infants comprise 4–7% of all newborns, in Africa they amount to 20–25% in some populations (Adelusi and Ladipo, 1976; Sprundel et al., 1981; van Eijk, 1986). In Nchelenge, the area in which the present study was conducted, LBW was present in 17.6–21.3% of hospital-delivered neonates, who are estimated to comprise about 30% of the total number of births in the district (Annual Report, 1984–1990). In Kenya, Tanzania, and Nigeria it has been observed that 31–74% of a group of LBW babies were premature (Adelusi and Ladipo, 1976; Meme and Hillman, 1977; Singh and Gupta, 1977; Mbise and Boersma, 1979; Bantje, 1982). From studies in Western countries it is known that premature infants show some, but insufficient, catch-up in height for age and weight for age during the first 6–8 postnatal months (Peterson et al., 1985; Binkin et al., 1988). This has also been reported from Kenya (Jansen et al., 1984).

Indeed, at Nchelenge, stunting prevalence at age 6–<12 months was comparable (60%) to that at 0–<6 months.

The existence of a substantial proportion of premature infants would have profound implications for the interpretation of anthropometrical data and derived rates of undernutrition. In Kenya, it was observed that both weight and length curves for LBW infants run parallel, but clearly at a lower level than those of infants with a normal birth weight (Jansen et al., 1984). In the Untied States, this has also been demonstrated for prematurely born children (Binkin et al., 1988). Furthermore, studies in Western countries have reported that severity of growth deficit will be overestimated if the age at measurement is not corrected for the number of weeks the child was premature (the difference between 40 weeks and gestational age). This held for up to 24 months for weight and 3.5 years for height (Brandt, 1978; Peterson et al., 1985). This probably holds for Africa as well, as indicated by the growth study of LBW infants in Kenya (Jansen et al., 1984).

In addition, at Nchelenge underweight occurred in 14.8% and wasting in 7.4% at age 0–<6 months. While these figures could be influenced by prematurity, as suggested above, there is the added possibility that some children became nutritionally compromised in utero and were born as small for gestational age (SGA) infants. Postnatally, some catch-up growth seems to have occurred, as reflected in lower rates of wasting at age 6–<12 months (0%) compared to 0–<6 months.

Support for the suggestion of intrauterine growth retardation comes from studies on birthweight in Africa. Whereas in a sample of Kenyan newborns mean head circumference was observed to be according to international reference values (rendering prematurity unlikely), mean birth weight was decreased, suggesting intrauterine growth delay (Ie et al., 1992). Similarly, decreased birth weights have been reported from Tanzania, Cameroun, Rwanda, Ivory Coast, Senegal, Nigeria, and Ethiopia, also in studies that considered only maturely born infants without any medical complications (Rehan and Tafida, 1979; Tafari et al., 1980; van Eijk, 1986). For example, dysmaturity has been observed in 41–50% of LBW babies from Tanzania and Nigeria, and in 15.8% of mature neonates from northern Nigeria (Adelusi and Ladipo, 1976; Mbise and Boersma, 1979; Rehan and Tafida, 1979). For a substantial proportion of African children nutritional deprivation may therefore start before birth.

In the United States, children with intrauterine growth retardation exhibited even less catch-up growth than prematurely born infants. At ages 6–48 months, SGA infants had lower heights and weights than those of the same birth weights born prematurely (Binkin et al., 1988). So, intrauterine growth retardation may lead to an even more permanent and substantial growth impairment than prematurity. The high percentage of LBW in African populations should be considered in the interpretation of growth data to prevent overestimation of growth retardation among under fives.

The Nchelenge survey was conducted at the end of the dry season and the beginning of the rainy season, the period during which agricultural demands take a heavy physical toll on women and food availability generally is low. In Cameroun, birthweights were observed to be lowest in the dry season, possibly due to an increase in premature deliveries (van Eijk, 1986). In Zaïre, the percentage of LBW was observed to be higher in the wet season (Newby and Lovel, 1995). Marked seasonal changes in mean birthweight have also been reported from Rwanda and Tanzania (van Sprundel et al., 1981; Bantje, 1982, 1983). In Ethiopia, heavy physical work during pregnancy was related to a decrease in birthweight among mature newborns (Tafari et al., 1980; van Eijk, 1986). In Tanzania, birthweights in periods of food shortage but without heavy field labor for women were not as low as in months during which both food resources were scarce and female physical activity was high. Maternal heavy field labor was therefore suggested to be the main determinant of the observed seasonal decrease in birthweight (Bantje, 1983). In rural Malawi, z scores of W/H as well as growth velocity showed substantial seasonal variation, especially under 2 years of age (Lindskog et al., 1987). So, at Nchelenge seasonal

factors may have adversely affected intrauterine growth, time of delivery, and postnatal catch-up growth.

In our study, wasting, defined as W/H $\leqq$ -2 z scores, occurred in 4.8% of the children 12–60 months old and in 7.6% of the 12–<24 month group. Use of an MUAC < 125 mm to indicate wasting gave a prevalence of 8.3% in children 12–60 months and 18.7% among the 12–<24 month group. Thus, at population level, use of the MUAC with 12.5 cm as cutoff value yielded too-high estimates of wasting prevalence.

If in individual children the MUAC was to be used as a screening test to indicate wasting and W/H as a confirmatory measurement, a high sensitivity and low false negative rate for the MUAC are indispensible, as otherwise many children with wasting never would be identified. The data in Table 3 show, firstly, that the generally accepted cutoff (MUAC < 125 mm) gave poor results in terms of sensitivity (25.0%) and false negative rate (75.0%) in the children aged 12–60 months. Secondly, changing the cutoff gave some improvement of the characteristics of the screening measure. Thirdly, the sensitivity and false negative rate in the age group 12–<24 months were somewhat more acceptable compared to those in children aged 24–60 months, but still were inadequate for use as a screening measure at population level.

This is in marked contrast with many studies from Africa and elsewhere, where use of the MUAC is advocated as an easy way to identify children with wasting (Blankhart, 1969; Shakir and Morley, 1974; Morley and Woodland, 1979; van Eijk, 1986; Yost and Pust, 1988; Zondag et al., 1992). For example, in Cameroun the sensitivity of the MUAC at a 125 mm cutoff to identify wasting was reported to be 75%. There were, however, marked local differences (van Eijk, 1986). In Tanzania, a 135 mm cutoff value of the MUAC was mentioned to identify wasting with 65% specificity and 67% sensitivity at age 12–59 months (Yost and Pust, 1988). In Bangladesh, use of the MUAC was reported to be as effective as other nutritional indices in predicting death of in-patient wasted children and a 125 mm cutoff yielded about 90% sensitivity (Briend et al., 1986). Also in Bangladesh, prevalence rates of wasting by MUAC < 125 mm were similar to those by W/H < -2 z scores, although considerable local differences were observed (HKI Nutritional Surveillance Project, 1993). Other studies, however, report less favorable results for the MUAC as a screening test for wasting. In northeast Brazil, the sensitivity of the MUAC was observed to be 29% at most (Rees et al., 1987). Among Khmer children, MUAC measurement at a cutoff of 125 mm failed to identify more than half of the wasted children (Thompson, 1987). Apparently, the usefulness of the MUAC as a screening test for wasting depends to a great extent on local circumstances, among them the prevalence rate of wasting and, possibly, prematurity. In the population examined in the present study, it must be concluded that use of the MUAC yielded a rough estimate of the prevalence of wasting, but was not suitable as a screening instrument for wasting.

CONCLUSION

In a survey among households with children 0–60 months by means of a two-stage clustered sampling procedure in Nchelenge District, Zambia, prevalence rates of 30% underweight, 69.2% stunting, and 4.4% wasting were found, with the highest rates at age 12–<24 months. Prevalence figures of stunting, underweight, and wasting in children aged 0–<6 months and 6–<12 months suggested that a substantial proportion of infants were premature and/or small for gestational age. This should be considered in the interpretation of growth data. Use of the MUAC with 125 mm as cutoff resulted in higher estimates of wasting compared to W/H < -2 z scores, and seemed unsuitable as a screening test for wasting in this population.

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